CSE 311 Section 1

Propositional Logic

Administrivia & Introductions



Homework

- Submissions
 - LaTeX (highly encouraged)
 - overleaf.com
 - template and LaTeX guide posted on course website!
 - Word Editor that supports mathematical equations
 - Handwritten neatly and scanned
- All homeworks will be turned in via Gradescope
- Homeworks typically due on Wednesdays at 11:59 PM
- You have 6 late days total to use throughout the quarter
 - Anything beyond that will result in a deduction on further late assignments
- Only 3 late days max can be used per assignment

Announcements & Reminders

- Sections are Graded
 - You will be graded on section participation, so please try to come \bigcirc
 - When you can't come to section, do the problems on the calendar and email your TA by Sunday with your solutions (more details on Ed)
- Section Materials
 - Handouts will be provided in at each section
 - Worksheets and sample solutions will be available on the course calendar later this evening
- HW1
 - Due Wednesday Oct 2

Your TAs

- TA 1
 - content
- TA 2
 - content

Tips for 311!

- Tackling challenging homework problems may feel intimidating at first but **don't go at it alone**! <u>Find study groups, join us in office hours, book one-on-ones, and ask questions on</u> <u>Ed.</u>
- Section will often be challenging and fast but valuable for your learning. This is your time to ask lots of questions and clarify your learning!
- Sometimes homework problems will mirror section problems, use that to your advantage!
- This class is the best time to learn how to Latex, please consider learning now as it will save you time for future courses! Feel free to come to office hours to get help with Latex!
- This class moves quickly, so the sooner you identify gaps in your learning, the better. (Don't wait to discover gaps in your learning in the final week)

Icebreaker

- Small groups of 4-6ish
- Please share with your group
 - Your name
 - Number of years in department/ at UW
 - What was something fun you did over Summer break?
 - What are you concerned about for 311 / what are you excited about?
- Then, share how you like to eat your potatoes (baked, fried, chips, etc.)
- We'll go around and see what style of potato is most popular!

Propositions & Implications



Quick Concept Review

- **Propositions** are statements with a boolean truth value!
 - **"The AQI of Seattle is 50**" is a proposition. We know it's either true or false.
 - "The AQI of Seattle?" is not. Suddenly it could be hundreds of values.
 - In formal logic, we like to assign a proposition into a variable for later use.
- **Logical connectives** connect propositions to form new propositions!

 $\neg p$ $p \land q$ $p \lor q$ $p \rightarrow q$ $p \leftrightarrow q$

Truth Tables

Gives us a simple way to describe how logical connectives operate



р	q	p∧q
Т	Т	Т
Т	F	F
F	Т	F
F	F	F

р	q	p∨q
Т	Т	Т
Т	F	Т
F	Т	Т
F	F	F

Implications

Some common formulations:

p implies q whenever p is true q must be true If p then q q if p p is sufficient for q p only if q q is necessary for p



Vacuous truths: a false hypothesis, but true truth value



If I attended my 8:30 am class then I woke up early

"Only if"

I attended my 8:30am class only if I woke up early

If I woke up early then I attended my 8:30 am class

NOT Equivalent: The original statement **does not specify** what happens **when you wake up early**, you can wake up early to go play tennis in the morning!

If I attended my 8:30 am class then I woke up early

Equivalent: The original statement only **specifies exactly** what happened **when you went to your 8:30 class**, you had to have woken up early. Nothing else could have happened for you to be attending the 8:30 class.





Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

(a) If I am lifting weights this afternoon, then I do a warm-up exercise.

(b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

a) If I am lifting weights this afternoon, then I do a warm-up exercise.

Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

a) If I am lifting weights this afternoon, then I do a warm-up exercise.

Step 1 *p*: I am lifting weights this afternoon *q*: I do a warm-up exercise

Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

a) If I am lifting weights this afternoon, then I do a warm-up exercise.

Step 1 *p*: I am lifting weights this afternoon *q*: I do a warm-up exercise

 $\begin{array}{l} \textbf{Step 2} \\ \textbf{If } p \textbf{ then } q \end{array}$

Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

a) If I am lifting weights this afternoon, then I do a warm-up exercise.

Step 1 *p*: I am lifting weights this afternoon *q*: I do a warm-up exercise

 $\begin{array}{l} \textbf{Step 2} \\ \textbf{If } p \textbf{ then } q \end{array}$

Step 3 $p \rightarrow q$

Problem 2

- a) Whenever I walk my dog, I make new friends.
- b) I will drink coffee, if Starbucks is open or my coffeemaker works.
- c) Being a U.S. citizen and over 18 is sufficient to be eligible to vote.
- d) I can go home only if I have finished my homework.
- e) Having an internet connection is necessary to log onto zoom.
- f) I am a student because I attend university.

Work on parts (a), (c), and (f) with the people around you, and then we'll go over it together!

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

a) Whenever I walk my dog, I make new friends.

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

a) Whenever I walk my dog, I make new friends.

Step 1

p: I walk my dog*q*: I make new friends

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

a) Whenever I walk my dog, I make new friends.

Step 1

p: I walk my dog*q*: I make new friends

Step 2

Whenever p, qIf p then q

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

a) Whenever I walk my dog, I make new friends.

Step 1

p: I walk my dog*q*: I make new friends

Step 2

Whenever p, qIf p then q

Step 3

 $p \rightarrow q$

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

- 1. Create propositional variables
- 2. Replace all propositions
- c) Being a U.S. citizen and over 18 is sufficient to be eligible to vote. with created variables
 - 3. Replace the operators

- 1. Create propositional variables
- 2. Replace all propositions
- Being a U.S. citizen and over 18 is sufficient to be eligible to vote. with created variables
 - 3. Replace the operators

Step 1

C)

- p: One is a U.S. Citizen
- *q*: One is over 18
- r: One is eligible to vote

- 1. Create propositional variables
- 2. Replace all propositions
- Being a U.S. citizen and over 18 is sufficient to be eligible to vote. with created variables
 - 3. Replace the operators

Step 1

C)

p: One is a U.S. Citizenq: One is over 18r: One is eligible to vote

Step 2

Being p and q is sufficient for rIf p and q then r

- 1. Create propositional variables
- 2. Replace all propositions
- Being a U.S. citizen and over 18 is sufficient to be eligible to vote. with created variables
 - 3. Replace the operators

Step 1

C)

p: One is a U.S. Citizenq: One is over 18r: One is eligible to vote

Step 2

Being p and q is sufficient for rIf p and q then r

Step 3 $(p \land q) \rightarrow r$

f) I am a student because I attend university.

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

f) I am a student because I attend university.

Step 1

p: I am a student

q: I attend university

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

f) I am a student because I attend university.

Step 1

p: I am a student
q: I attend university

Step 2

p because qIf q then p

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

f) I am a student because I attend university.

Step 1

p: I am a student
q: I attend university

Step 2

p because qIf q then p

Step 3

 $q \to p$

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

 b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Work on this problem with the people around you, and then we'll go over it together!

Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

 b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

- b) If I am cold and going to bed or I am two-years old, then I carry a blanket.
 Step 1
 - p:I am cold
 - q: I am going to bed
 - r: I am two-years old
 - s: I carry a blanket

NOTE: you need a subject for each proposition. "Going to bed" is not a proper proposition, you need to add the "I am" to make it a valid sentence, and thus a valid proposition!!!

Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

 b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Step 1

- *p*: I am cold*q*: I am going to bed*r*: I am two-years old
- s: I carry a blanket

Step 2 If p and q or r, then s

Steps:

- 1. Create propositional variables
- 2. Replace all propositions with created variables
- 3. Replace the operators

 b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Step 1

p: I am coldq: I am going to bedr: I am two-years olds: I carry a blanket

Step 2 If p and q or r, then s

Step 3 $[(p \land q) \lor r] \rightarrow s$

Problem 5

Consider the following sentence:

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

- a) Define propositional variables and translate the sentence into an expression in logical notation.
- b) Fill out a truth table for your expression.

Work on this problem with the people around you, and then we'll go over it together!

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

a) Define propositional variables and translate the sentence into an expression in logical notation.

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

a) Define propositional variables and translate the sentence into an expression in logical notation.

p: I am drinking tea*q*: I am eating a cookie

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

a) Define propositional variables and translate the sentence into an expression in logical notation.

p: I am drinking tea*q*: I am eating a cookie

 $(p \to q) \lor (q \to p)$

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} ightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} \rightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$
Т	Т			
Т	F			
F	Т			
F	F			

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} \rightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$
Т	Т	Т		
Т	F			
F	Т			
F	F			

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} ightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$
Т	Т	Т		
Т	F	F		
F	Т			
F	F			

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} ightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$
Т	Т	Т		
Т	F	F		
F	Т	Т		
F	F	Т		

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} \rightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$
Т	Т	Т	Т	
Т	F	F	Т	
F	Т	Т	F	
F	F	Т	Т	

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} ightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$
Т	Т	Т	Т	т
Т	F	F	Т	
F	Т	Т	F	
F	F	Т	Т	

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} ightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$
Т	Т	Т	Т	Т
Т	F	F	Т	т
F	Т	Т	F	
F	F	Т	Т	

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} \rightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$
Т	Т	Т	Т	Т
Т	F	F	Т	т
F	Т	Т	F	Т
F	F	Т	Т	

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

р	q	$\mathbf{p} ightarrow \mathbf{q}$	$\mathbf{q} ightarrow \mathbf{p}$	$(p \rightarrow q) \lor (q \rightarrow p)$
Т	Т	Т	Т	Т
Т	F	F	Т	т
F	Т	Т	F	Т
F	F	Т	Т	Т

That's All, Folks!

Thanks for coming to section this week! Any questions?